CONTROL CIRCUITS AND METHODS FOR INHIBITING ABRUPT ENGINE MODE TRANSITIONS IN A WATERCRAFT
Takashi Okuyama
Appl. No.: Unknown Atty Docket: ES.20105US0A

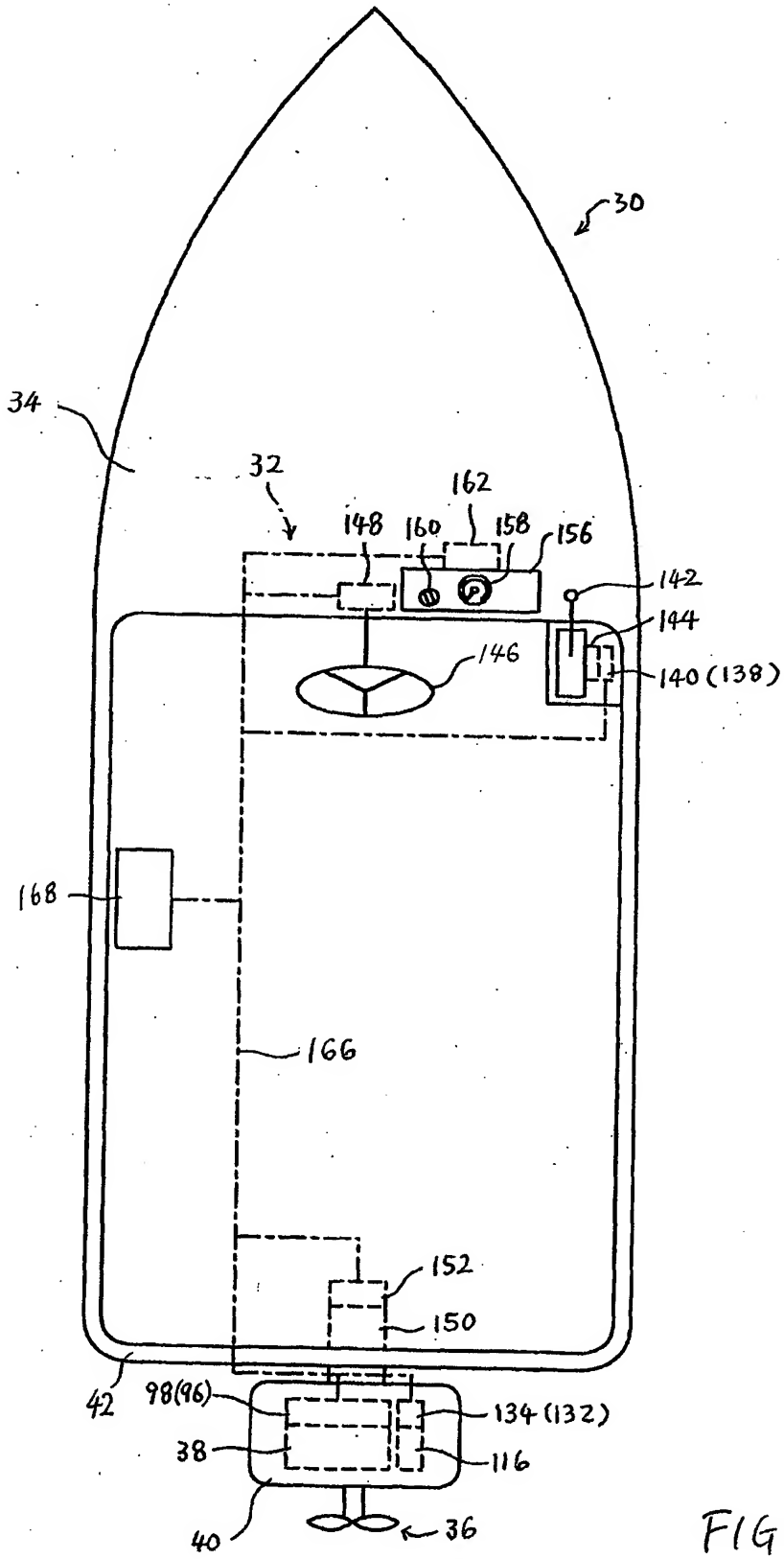

FIGURE 1

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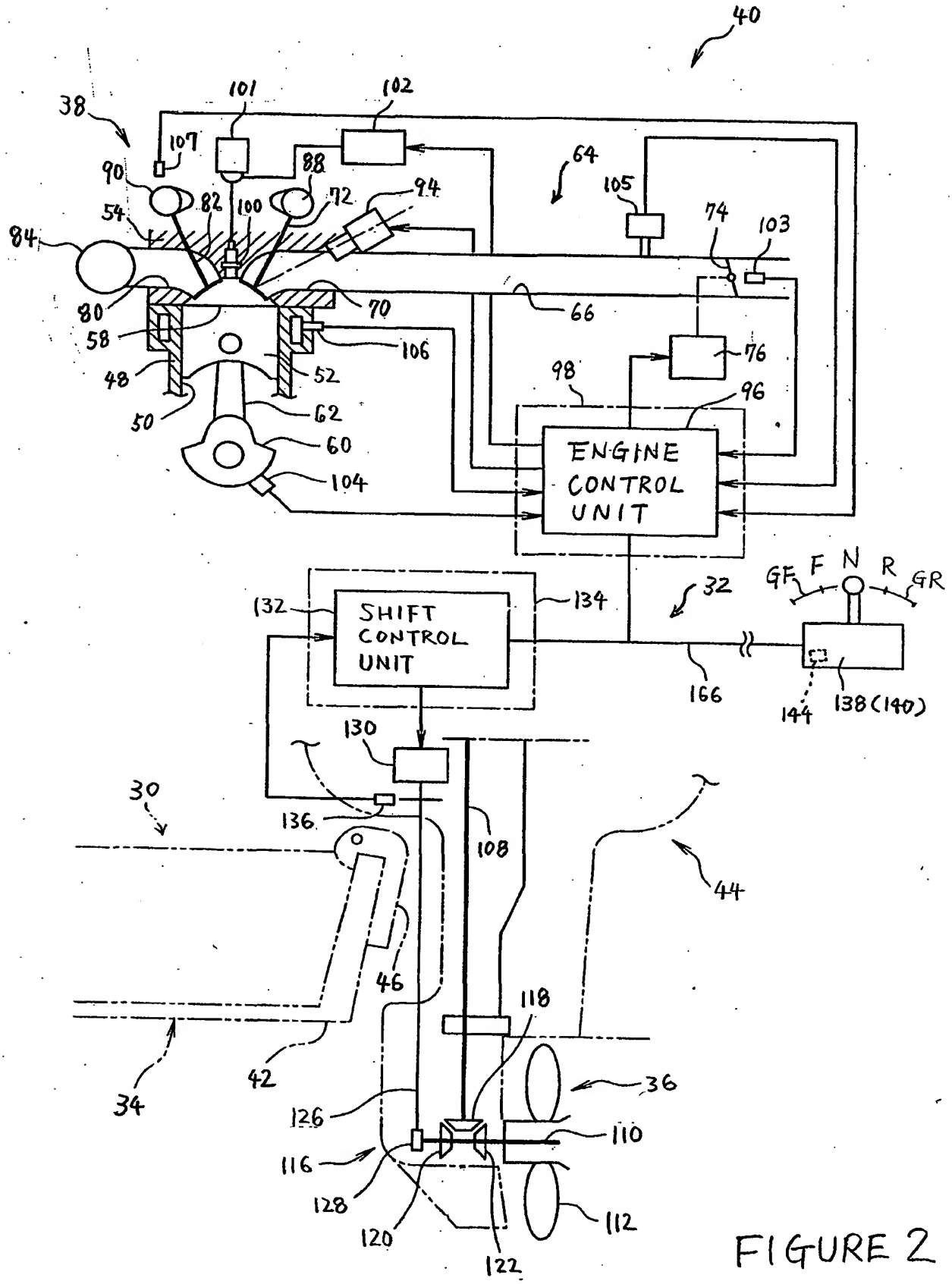

FIGURE 2

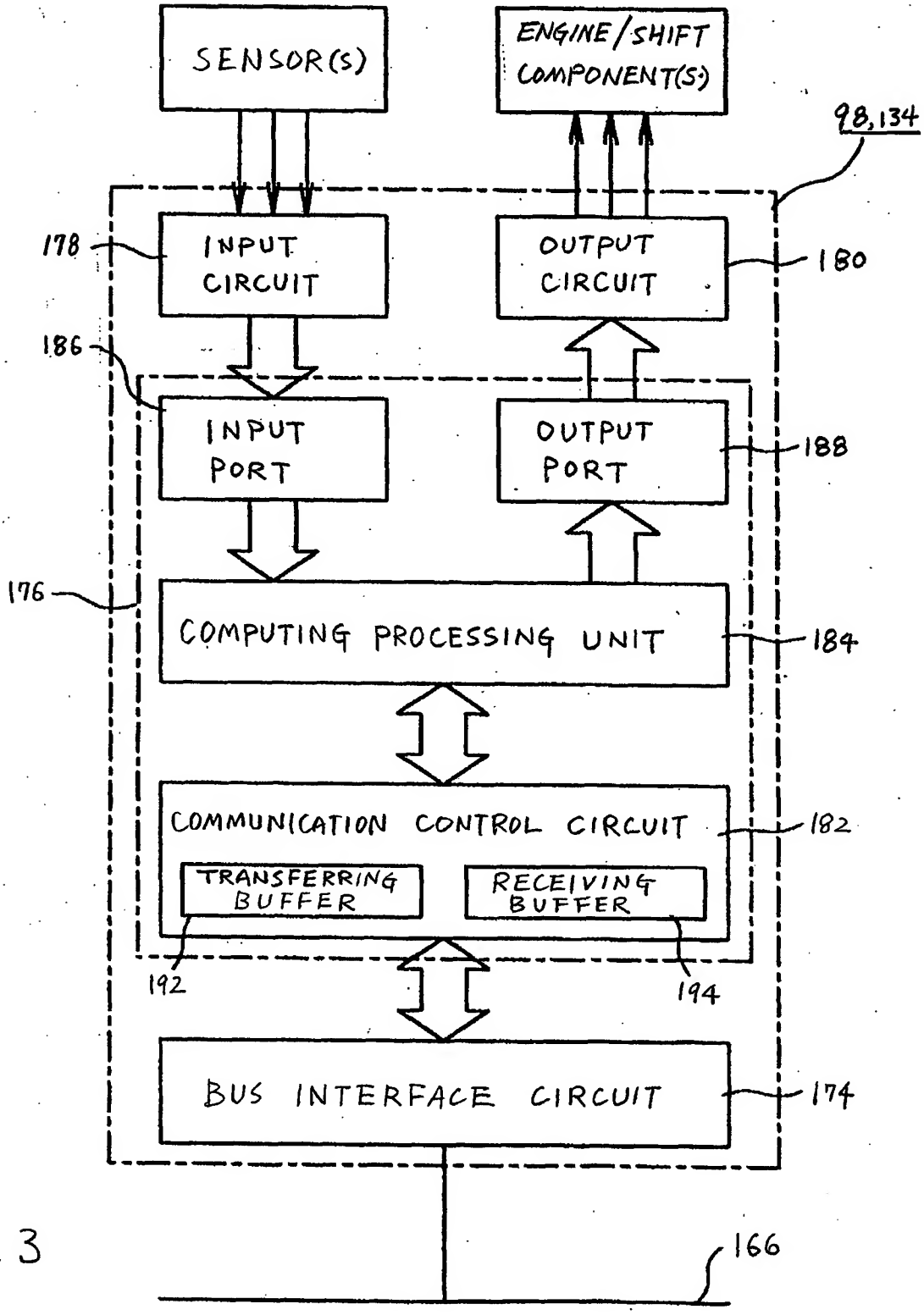
SENSOR(S)
ENGINE/SHIFT COMPONENT(S)
98,134
178
INPUT CIRCUIT
OUTPUT CIRCUIT
180
186
INPUT PORT
OUTPUT PORT
188
176
COMPUTING PROCESSING UNIT
184
COMMUNICATION CONTROL CIRCUIT
182
TRANSFERRING BUFFER
RECEIVING BUFFER
192
194
BUS INTERFACE CIRCUIT
174
166

FIGURE 3

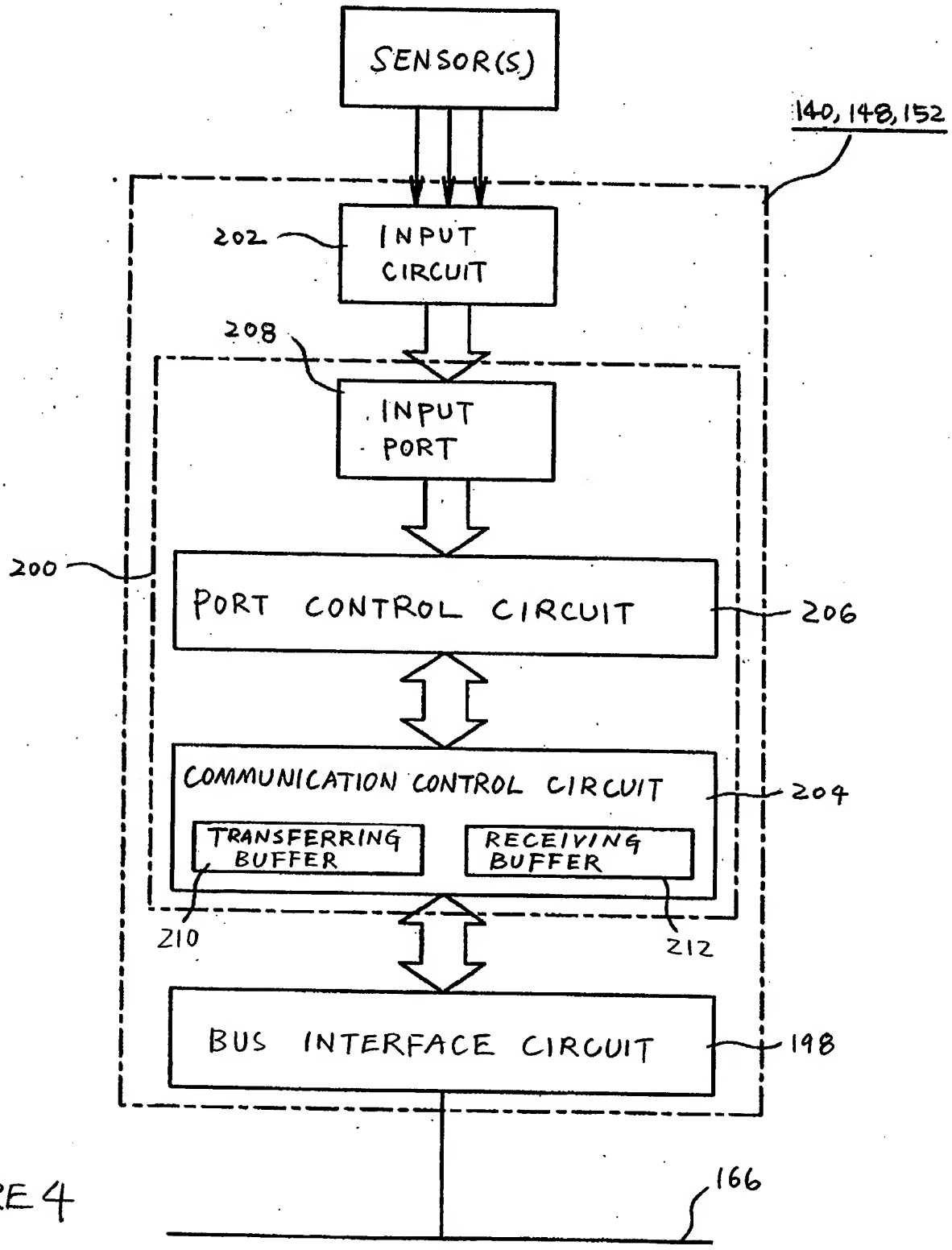
SENSOR(S)
140, 148, 152
202
INPUT CIRCUIT
208
INPUT PORT
200
PORT CONTROL CIRCUIT
206
COMMUNICATION CONTROL CIRCUIT
204
TRANSFERRING BUFFER
RECEIVING BUFFER
210
212
BUS INTERFACE CIRCUIT
198
166

FIGURE 4

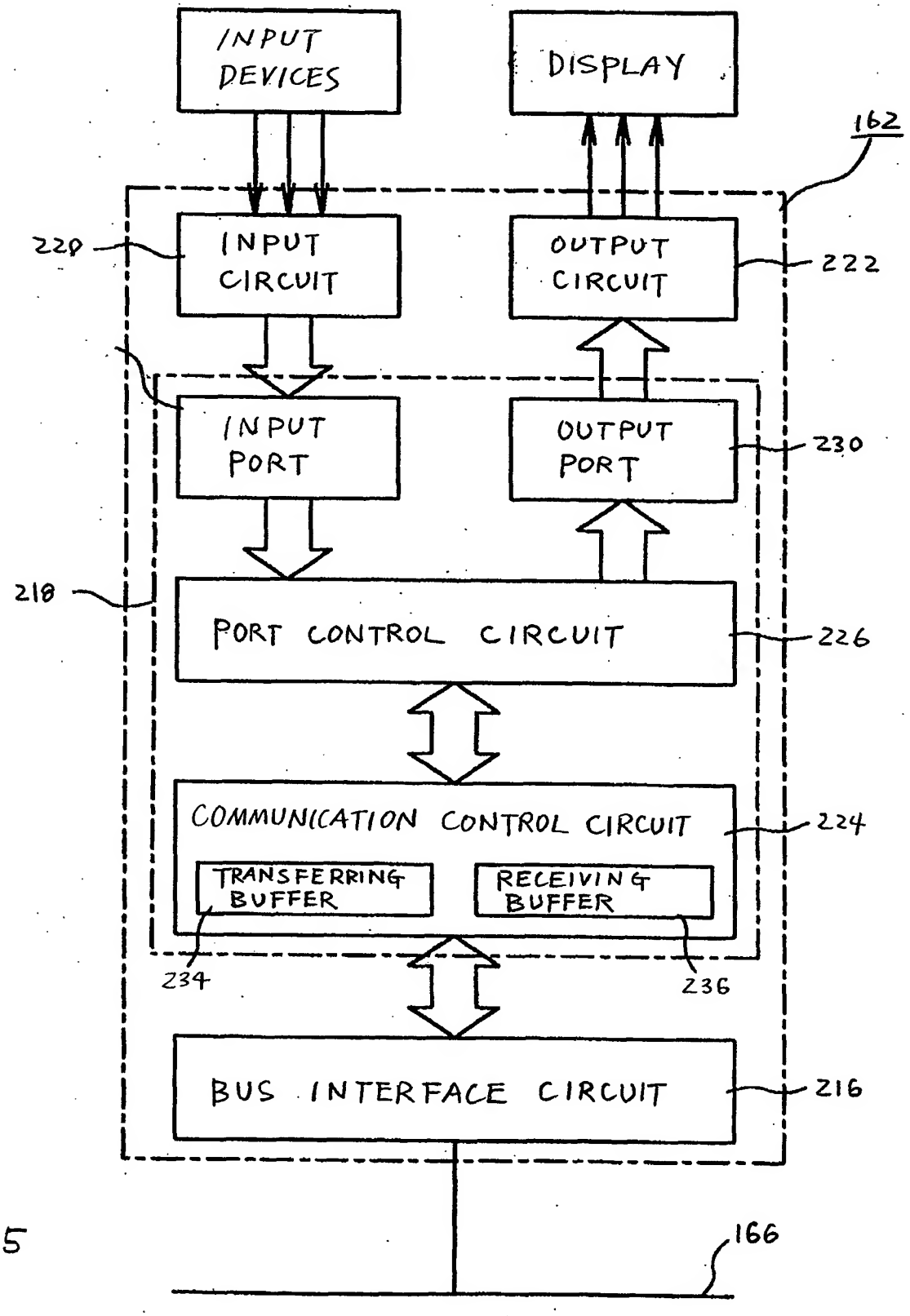
INPUT DEVICES
DISPLAY
162
220
INPUT CIRCUIT
OUTPUT CIRCUIT
222
INPUT PORT
OUTPUT PORT
230
218
PORT CONTROL CIRCUIT
226
COMMUNICATION CONTROL CIRCUIT
224
TRANSFERRING BUFFER
RECEIVING BUFFER
234
236
BUS INTERFACE CIRCUIT
216
166

FIGURE 5

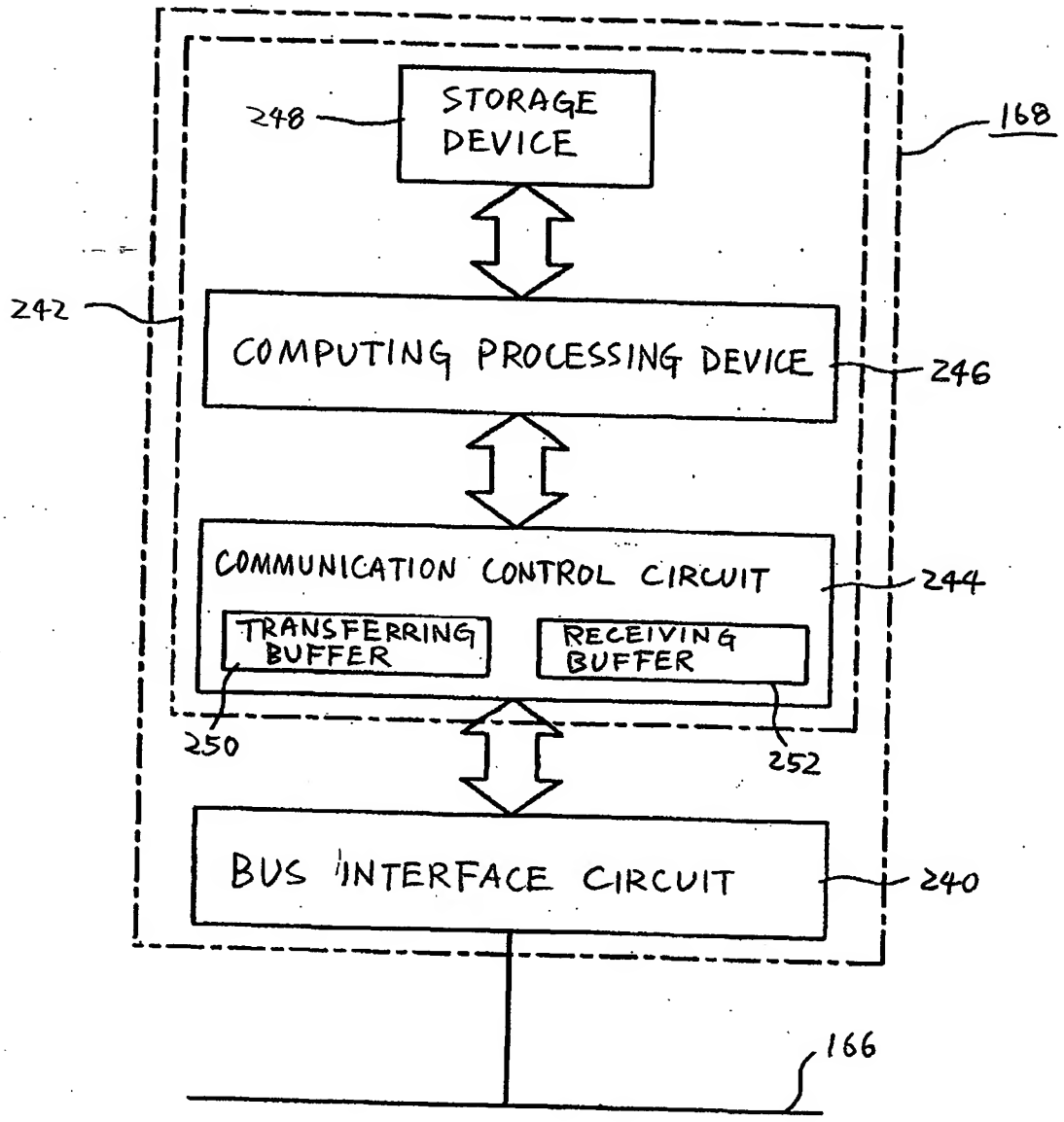
248
STORAGE DEVICE
168
242
COMPUTING PROCESSING DEVICE
246
COMMUNICATION CONTROL CIRCUIT
244
TRANSFERRING BUFFER
RECEIVING BUFFER
250
252
BUS INTERFACE CIRCUIT
240
166

FIGURE 6

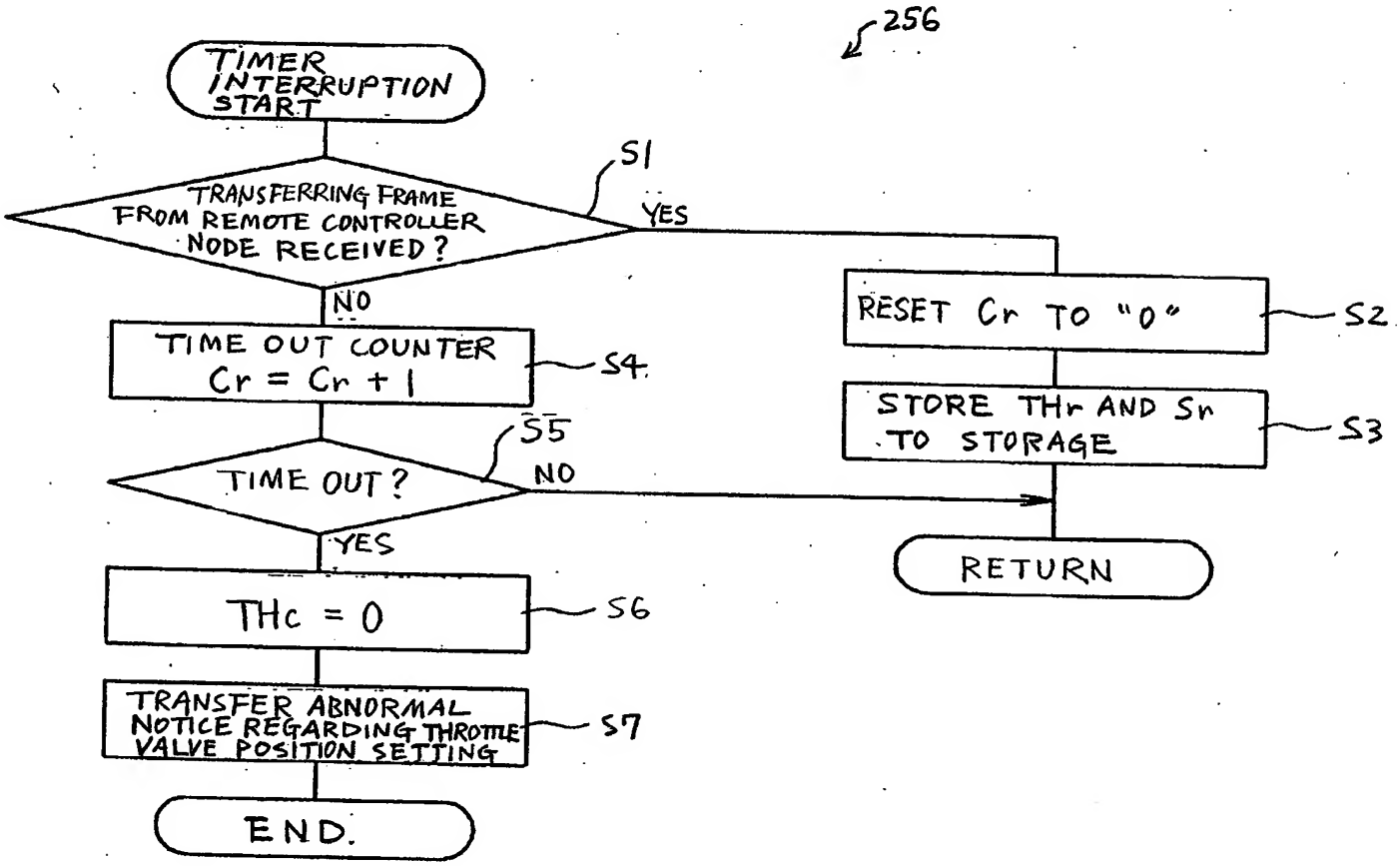
256
TIMER INTERRUPTION START
S1
TRANSFERRING FRAME FROM REMOTE CONTROLLER NODE RECEIVED?
YES
NO
RESET Cr TO "0"
S2
STORE THr AND Sr TO STORAGE
S3
TIME OUT COUNTER Cr = Cr + 1
S4
S5
TIME OUT?
NO
YES
RETURN
THc = 0
S6
TRANSFER ABNORMAL NOTICE REGARDING THROTTLE VALVE POSITION SETTING
S7
END.

FIGURE 7

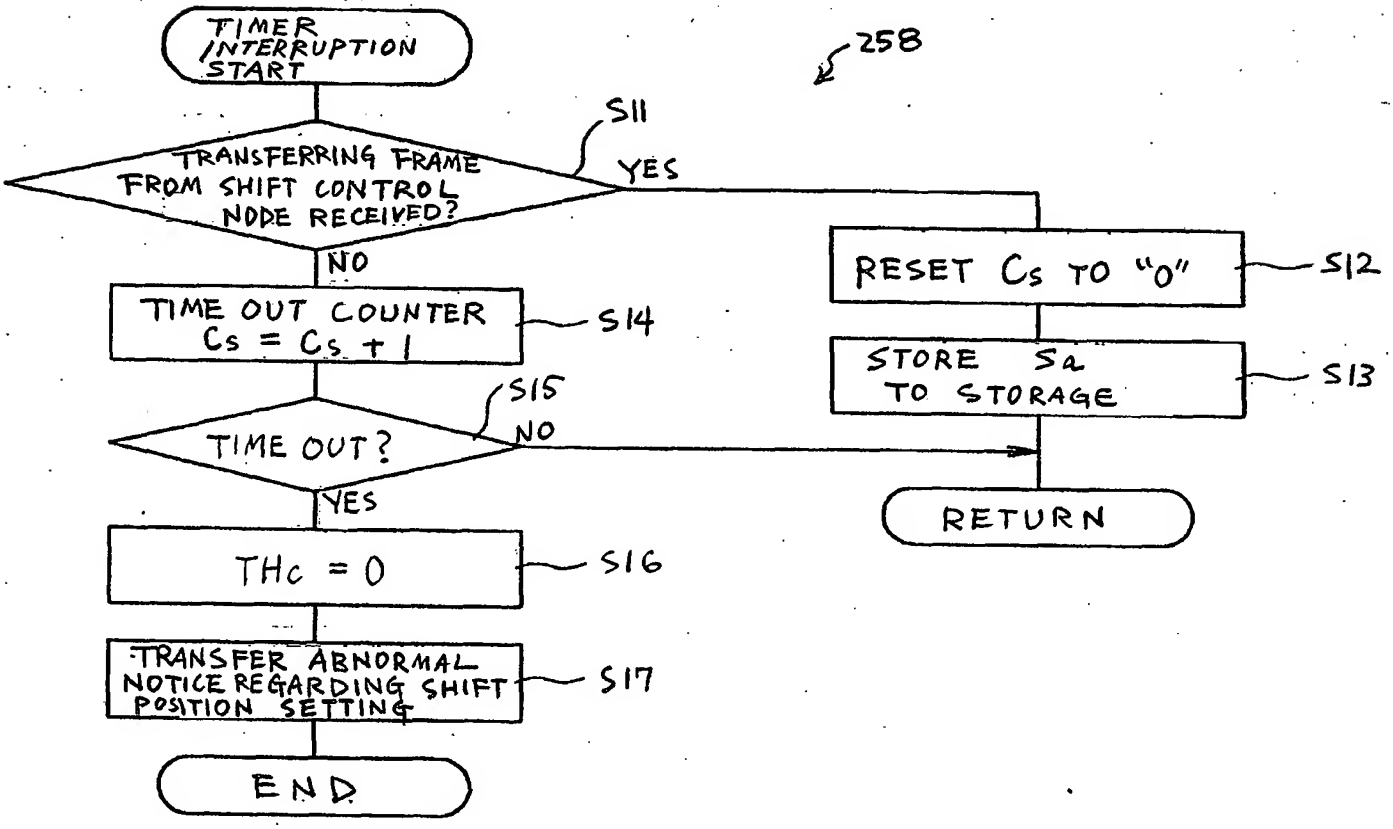
TIMER INTERRUPTION START
258
S11
TRANSFERRING FRAME FROM SHIFT CONTROL MODE RECEIVED?
YES
NO
RESET Cs TO "0"
S12
STORE Sa TO STORAGE
S13
TIME OUT COUNTER Cs = Cs + 1
S14
S15
TIME OUT?
NO
YES
RETURN
THc = 0
S16
TRANSFER ABNORMAL NOTICE REGARDING SHIFT POSITION SETTING
S17
END

FIGURE 8

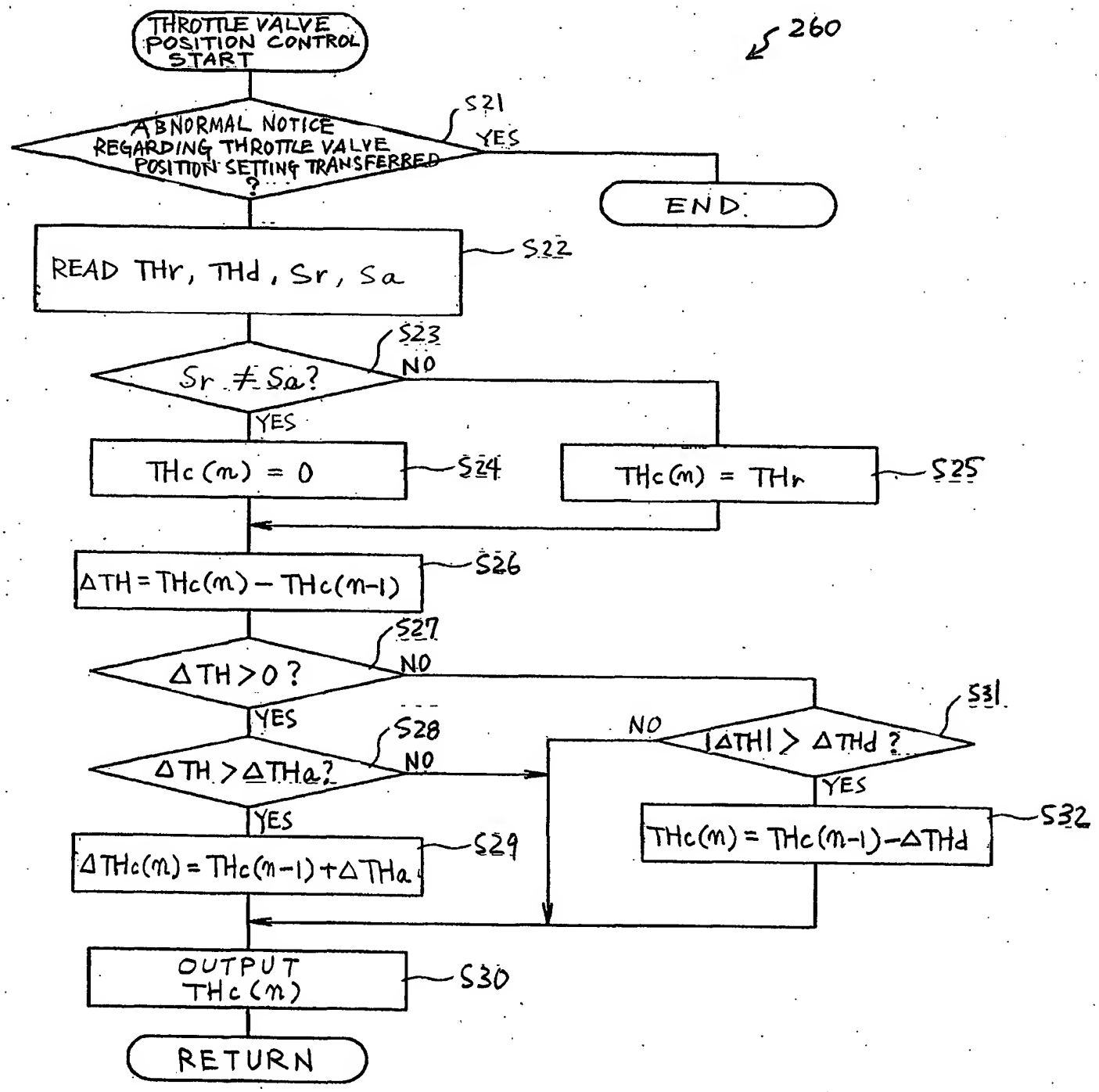
THROTTLE VALVE POSITION CONTROL START
260
S21
ABNORMAL NOTICE REGARDING THROTTLE VALVE POSITION SETTING TRANSFERRED ?
YES
END
READ THr, THd, Sr, Sa
S22
S23
Sr ≠ Sa?
NO
YES
THc(n) = 0
S24
THc(n) = THr
S25
ΔTH = THc(n) − THc(n-1)
S26
S27
ΔTH > 0 ?
NO
YES
S28
ΔTH > ΔTHa?
NO
YES
ΔTHc(n) = THc(n-1) + ΔTHa
S29
S31
NO
|ΔTH| > ΔTHd ?
YES
THc(n) = THc(n-1) − ΔTHd
S32
OUTPUT THc(n)
S30
RETURN

FIGURE 9

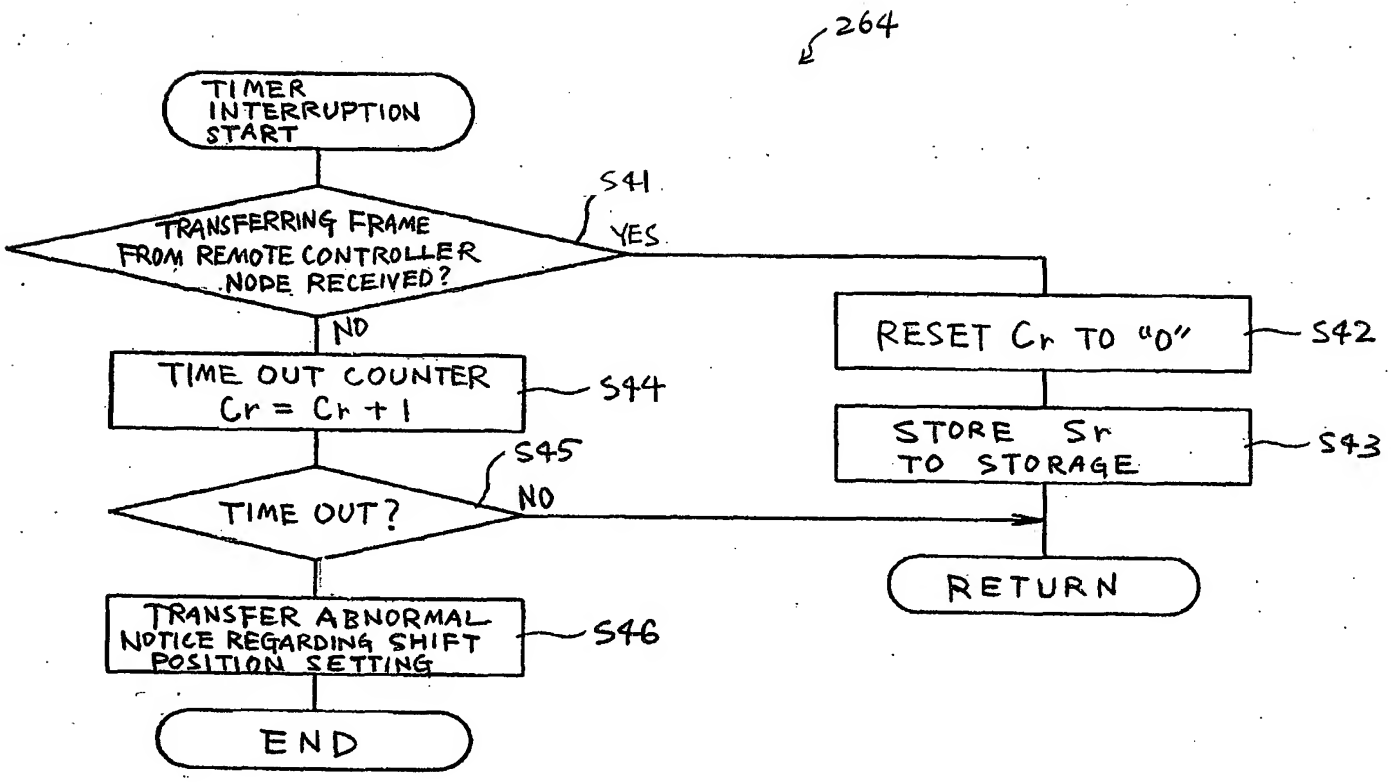
264
TIMER INTERRUPTION START
S41
TRANSFERRING FRAME FROM REMOTE CONTROLLER NODE RECEIVED?
YES
ND
RESET Cr TO "0"
S42
TIME OUT COUNTER Cr = Cr + 1
S44
STORE Sr TO STORAGE
S43
S45
TIME OUT?
NO
RETURN
TRANSFER ABNORMAL NOTICE REGARDING SHIFT POSITION SETTING
S46
END

FIGURE 10

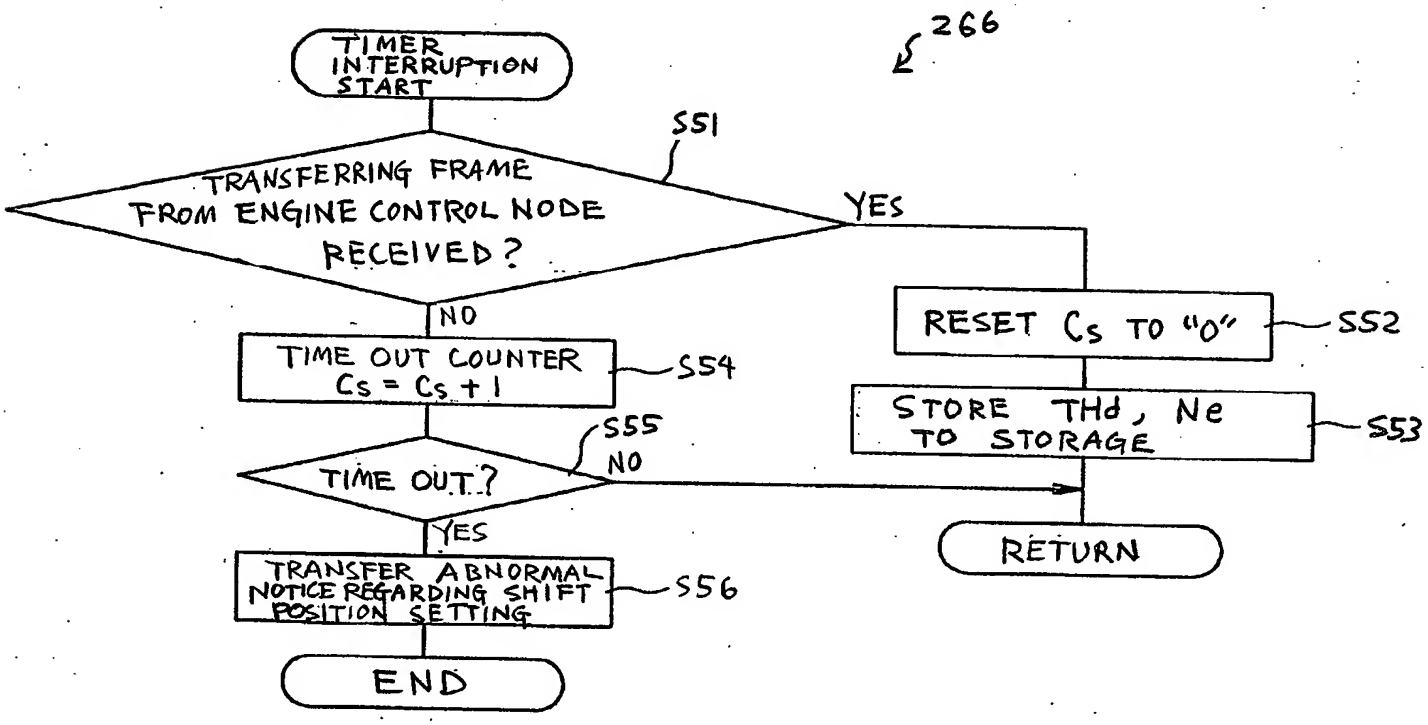
266
TIMER INTERRUPTION START
S51
TRANSFERRING FRAME FROM ENGINE CONTROL NODE RECEIVED?
YES
NO
RESET Cs TO "0"
S52
STORE THd, Ne TO STORAGE
S53
TIME OUT COUNTER Cs = Cs + 1
S54
S55
TIME OUT?
NO
YES
RETURN
TRANSFER ABNORMAL NOTICE REGARDING SHIFT POSITION SETTING
S56
END

FIGURE 11

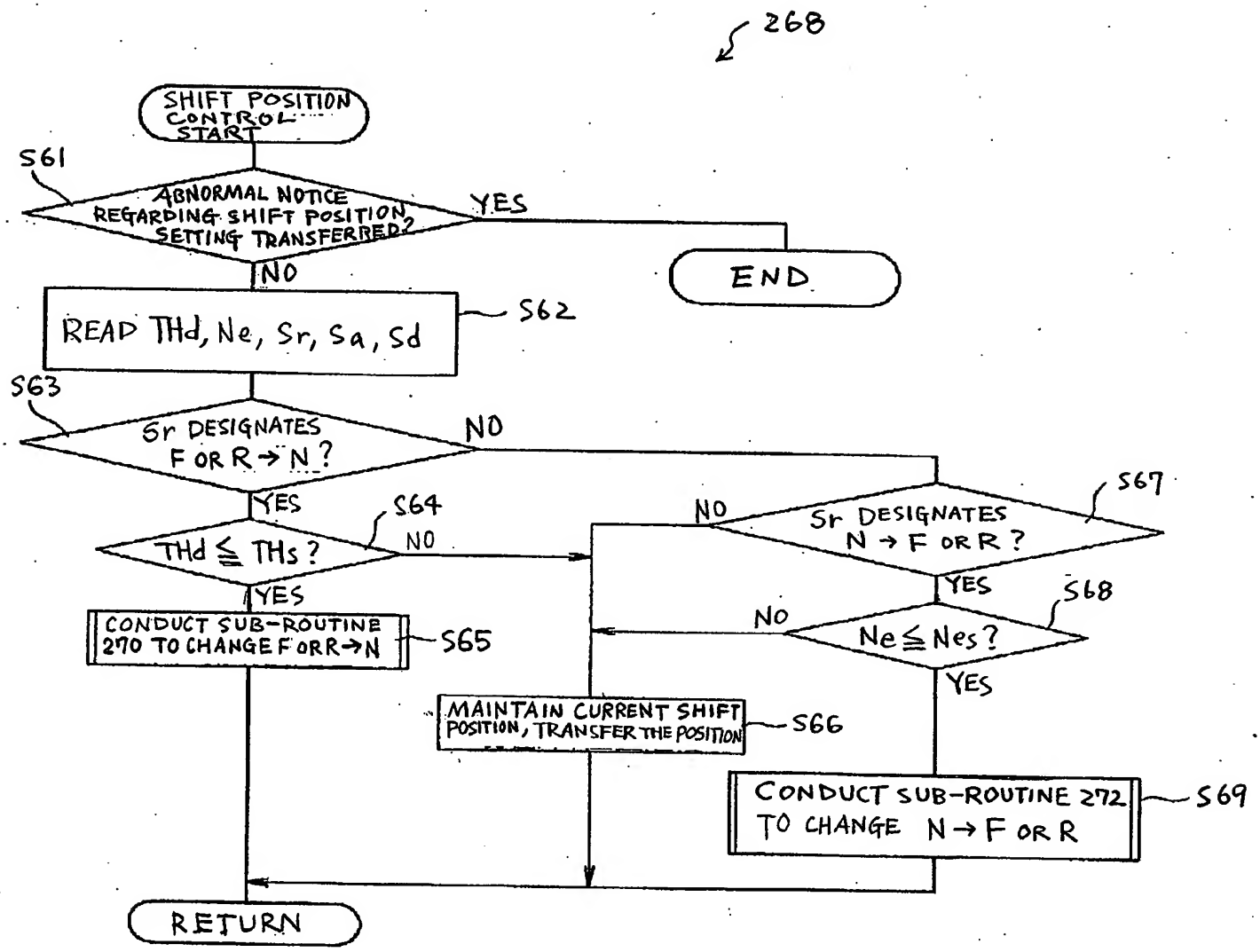
268
SHIFT POSITION CONTROL START
S61
ABNORMAL NOTICE REGARDING SHIFT POSITION SETTING TRANSFERRED?
YES
END
NO
READ THd, Ne, Sr, Sa, Sd
S62
S63
Sr DESIGNATES F OR R → N?
NO
YES
S64
THd ≦ THs?
NO
YES
CONDUCT SUB-ROUTINE 270 TO CHANGE F OR R → N
S65
S67
Sr DESIGNATES N → F OR R?
NO
YES
S68
Ne ≦ Nes?
NO
YES
MAINTAIN CURRENT SHIFT POSITION, TRANSFER THE POSITION
S66
CONDUCT SUB-ROUTINE 272 TO CHANGE N → F OR R
S69
RETURN

FIGURE 12

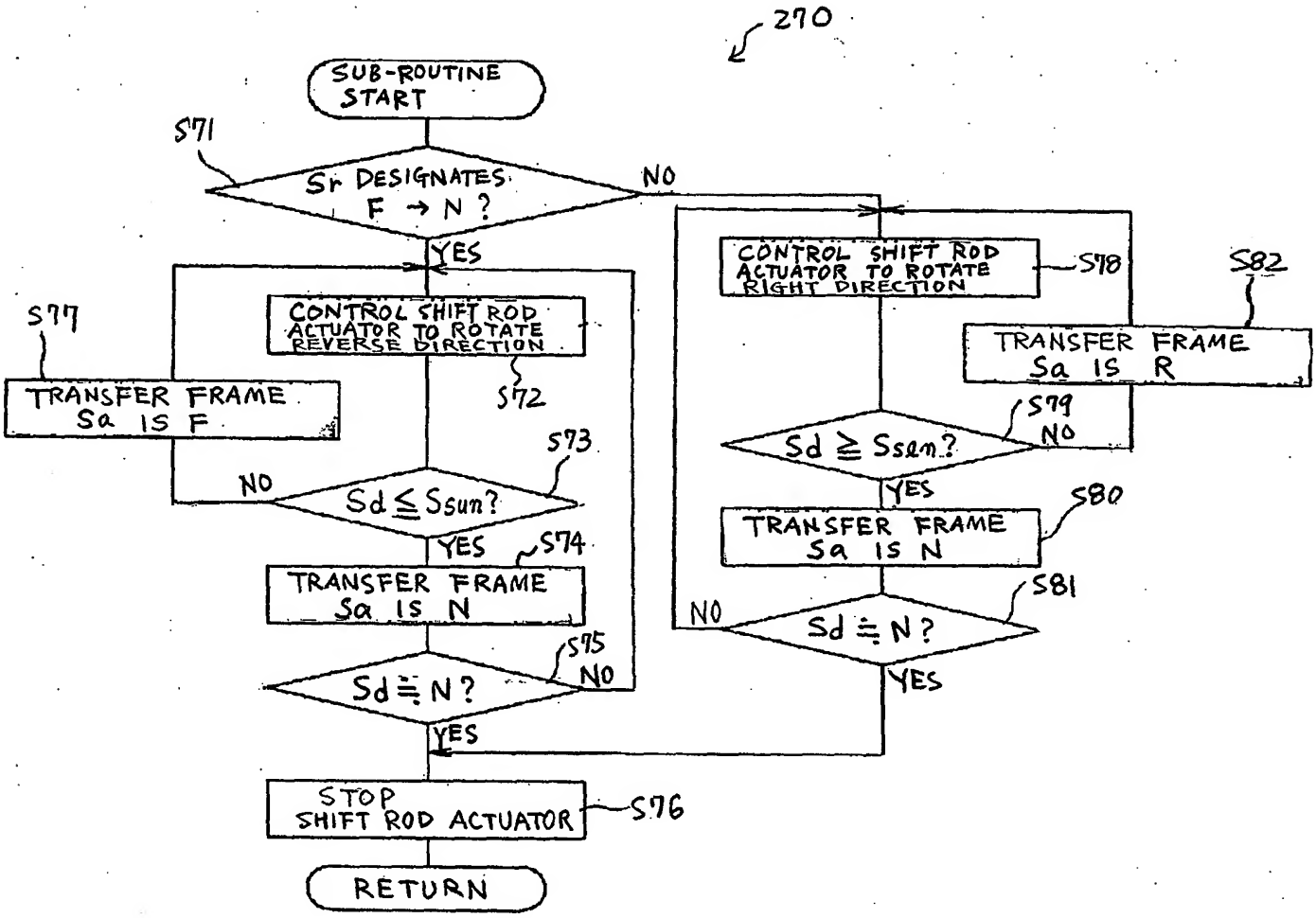
270
SUB-ROUTINE START
S71
Sr DESIGNATES F → N ?
NO
YES
CONTROL SHIFT ROD ACTUATOR TO ROTATE REVERSE DIRECTION
S72
S77
TRANSFER FRAME Sa IS F
S73
NO
Sd ≦ Ssun?
YES
S74
TRANSFER FRAME Sa IS N
S75
Sd ≒ N?
NO
YES
CONTROL SHIFT ROD ACTUATOR TO ROTATE RIGHT DIRECTION
S78
S82
TRANSFER FRAME Sa IS R
S79
NO
Sd ≧ Ssun?
YES
S80
TRANSFER FRAME Sa IS N
S81
NO
Sd ≒ N?
YES
STOP SHIFT ROD ACTUATOR
S76
RETURN

FIGURE 13

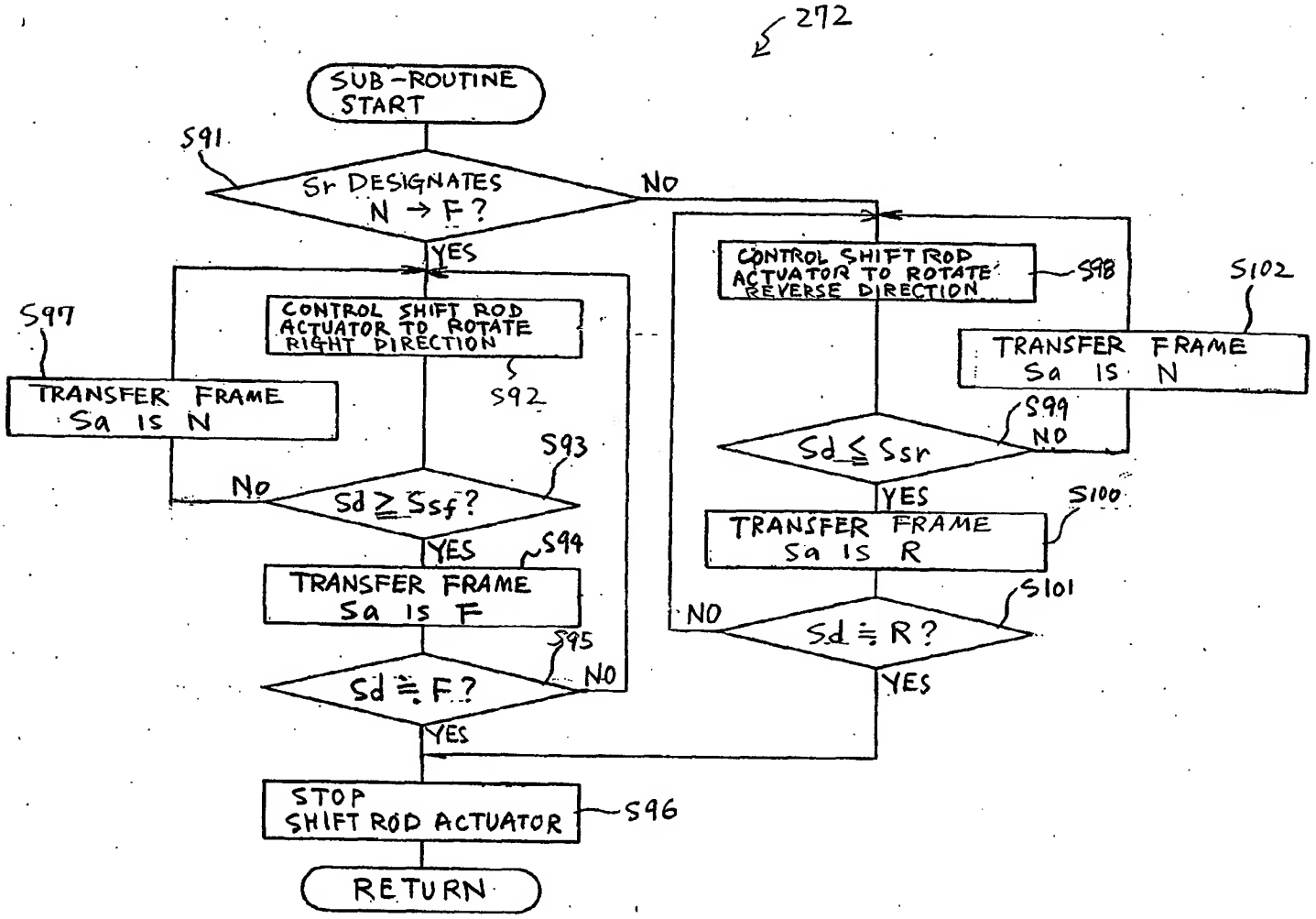
272
SUB-ROUTINE START
S91
Sr DESIGNATES N → F?
NO
YES
CONTROL SHIFT ROD ACTUATOR TO ROTATE RIGHT DIRECTION
S92
S97
TRANSFER FRAME Sa IS N
S93
NO
Sd ≧ Ssf?
YES
S94
TRANSFER FRAME Sa IS F
S95
Sd ≒ F?
NO
YES
STOP SHIFT ROD ACTUATOR
S96
RETURN
CONTROL SHIFT ROD ACTUATOR TO ROTATE REVERSE DIRECTION
S98
S102
TRANSFER FRAME Sa IS N
S99
NO
Sd ≦ Ssr
YES
S100
TRANSFER FRAME Sa IS R
S101
NO
Sd ≒ R?
YES

FIGURE 14

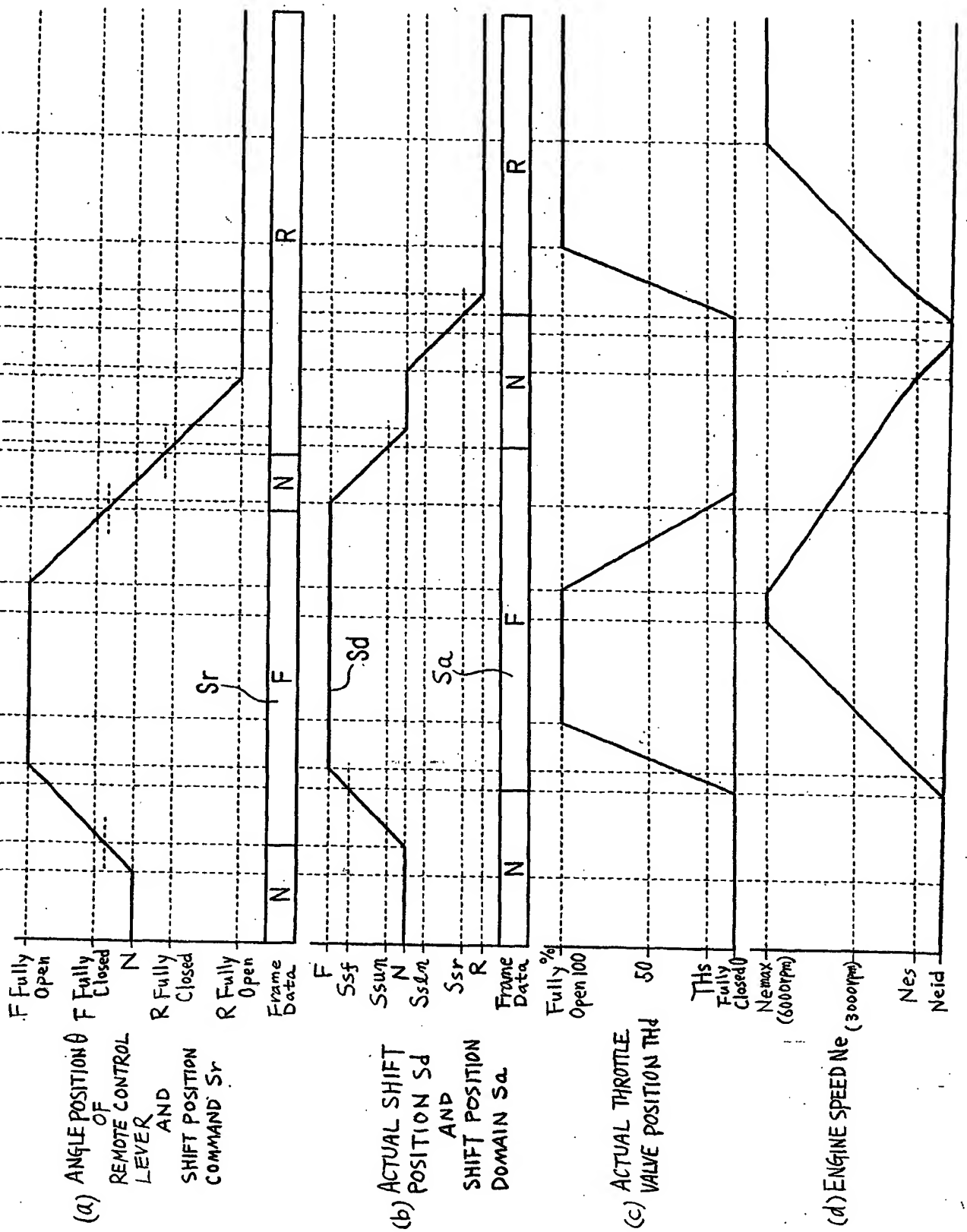
t1 t2 t3 t4 t5 t6 t7 t8 t9 t10 t11 t12 t13 t14 t15 t16 t17 t18 t19
F Fully Open
F Fully Closed
N
R Fully Closed
R Fully Open
Frame Data
N
F
R
Sr
(a) ANGLE POSITION θ OF REMOTE CONTROL LEVER AND SHIFT POSITION COMMAND Sr
F
Ssf
Ssun
N
Ssln
Ssr
R
Frame Data
N
F
R
Sd
Sa
(b) ACTUAL SHIFT POSITION Sd AND SHIFT POSITION DOMAIN Sa
Fully % Open 100
50
THs
Fully Closed 0
(c) ACTUAL THROTTLE VALVE POSITION THd
Nemax (6000rpm)
(3000rpm)
Nes
Neid
(d) ENGINE SPEED Ne

FIGURE 15

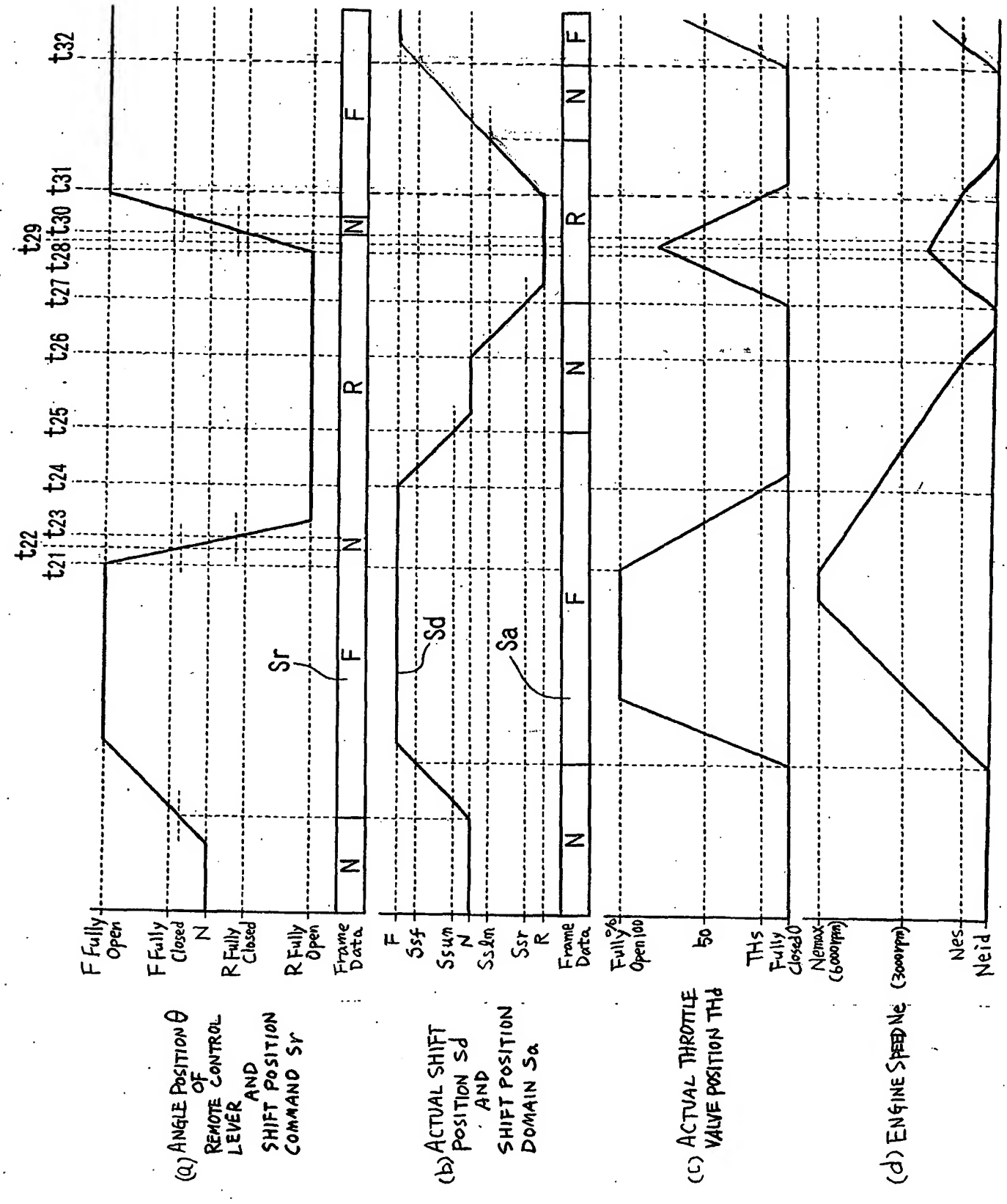
t21
t22
t23
t24
t25
t26
t27
t28
t29
t30
t31
t32
F Fully Open
F Fully Closed
N
R Fully Closed
R Fully Open
Frame Data
N
F
N
R
N
F
Sr
F
Ssf
Sd
Ssum
N
Sslm
Sa
Ssr
R
Frame Data
N
F
N
R
N
F
Fully% Open 100
to
THs
Fully Closed 0
Nemax (6000rpm)
Nes
Neid
(a) ANGLE POSITION θ OF REMOTE CONTROL LEVER AND SHIFT POSITION COMMAND Sr
(b) ACTUAL SHIFT POSITION Sd AND SHIFT POSITION DOMAIN Sa
(c) ACTUAL THROTTLE VALVE POSITION THd
(d) ENGINE SPEED Ne (3000rpm)

FIGURE 16